

# INDUSTRY INTERNSHIP IN LOCAL INDUSTRIES TO IMPROVE ENGINEERING DESIGN COMPETENCE OF UNDERGRADUATE ENGINEERING STUDENTS

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## Abstract

The aim of this study is to design a model of industry internship program in local industries for undergraduate engineering students to improve their engineering design competence. The students take this industry internship model in two months. During this program, the students, working in groups, design a machine or device that is needed by the local industries at that time. Methods used to analyse the effectiveness of the internship program in improving student's engineering design competence were observation during the program and product performance test. There were three groups of students taking the internship program in two different local industries. The student's engineering design competence were assessed in four different attributes: knowledge of procedures, operational skills, social skills and cognitive skills. Then, the results of these assessment were compared with those of students taking conventional industry internship. The product performance test was done to assess the quality of the machine. Results of the test showed that in all attributes of the competence (knowledge of procedures, operational skills, social skills and cognitive skills of the students) were better than those of students taking conventional industry internship. Results from the product performance test showed that the machines produced by the students taking the program had worked well.

Key words: industry internship, engineering design, competence, undergraduate student

## Introduction

Indonesia is a developing country with more than 250 millions people. Most of them live in rural areas and have low economic and academic background. To provide better labour forces and to decrease the number of unemployment, the Government increases the number of vocational schools. In addition, local industries with low technology are developed to employ low educated workforces.

One program called industry internship in vocational schools is held to give an opportunity for students having a real experience in industry. Nancy O'Neill [1] stated that for those students who are clearer about their career interests and academic pursuits, an internship can help them apply what they are learning in "real world" settings, gain more substantial professional experience, and begin to develop a network of people in fields that interest them. From this statement, it is

clear that internship program is a "bridge" connecting between academic world (classroom) and real world. For engineering students, mostly their real world is industries.

There are many models of internship. One of them is developed by Kiser (2000) [2]. Her model consists of four-stage: (a) pre-placement, (b) initiation, (c) working, and (d) termination. The pre-placement stage occurs before actually conducting the internship. It encompasses the process of identifying, investigating, interviewing and determining an internship placement site with input from the potential internship supervisor and academic instructor. After a mutual decision is agreed upon, pre-placement activities include setting a work schedule, continuing contact with the future internship supervisor, rearranging personal schedules and activities to include the demanding responsibilities inherent with an internship placement.

The initiation stage occurs when the internship experience actually begins. Orientation, becoming familiar with co-workers and clients, and becoming acquainted with agency policies and procedures are routinely associated with this second stage. Students observe their new surroundings while supervisors assess students' strengths and weaknesses.

The working stage is the time for students to accomplish tasks and to reach the internship goals. During this stage, students and supervisors become more comfortable communicating and identifying personal strengths and admitting limitations. Students work as regular workers, get an increasing self-confidence and work more autonomously.

Termination, the last of the four stages, begins when plans for ending the internship are considered. At this stage, it is important for students to complete tasks or give incomplete tasks to others. The internship supervisor accomplish assessment and feedback. It is also a time for the student to reflect on his/her performance, as well as professional and personal lessons learned.

To further improve the effectiveness of the industry internship, this paper will present a model of industry internship program in local industries for undergraduate engineering students to improve their engineering design competence.

### **Engineering Design Competencies**

Engineering design is iterative, creative, at times both analytic and synthetic, incorporates elements of problem-solving, and incorporates intuitive as well as heuristic methodologies. Therefore, many engineering educators should teach and train students to understand how to generate design specifications and how to proceed from design specifications to a final product based on the specified objectives and criteria. The Canadian Engineering Board has proposed the definition of engineering design (CEAB 2002), engineering design integrates mathematics, basic sciences, engineering sciences and complementary

studies in developing elements, systems and process to meet specific needs.

The perspective on design competency relates to the broad context of the practice of engineering. According to [3] the NSERC Design Chair Group, there are seven types of knowledge and skill competencies needed by engineers working on engineering design (Table 1). First, general knowledge, that is a knowledge needed to understand a phenomenon, a situation, a problem, a process, etc. Second, specific knowledge in a professional environment, that is knowledge of the technologies, the rules, the standards, the culture, etc. needed in working on design process. Third, knowledge of procedures, methods and processes, such as product development process, engineering design process, engineering design tools (market research, functional analysis, QFD, design for cost and cost estimation, etc).

Fourth, operational skills, such as how to use the procedures, the methods, the technologies, etc. Fifth, experiential skills, that is to know how to use tacit knowledge, such as doing design by similarity, design by experience, etc. Sixth, social/personal skills, these are to know how to listen, to cooperate, to work in team, to manage life (personal and professional), to feel (intuition, perception, etc.). Seventh, cognitive skills, these are skills needed to solve problem, to design, to manage a project, to take decisions, etc.

Based on "Reference 3", this study designed an assessment to measure internship student competency in engineering design in four categories to encompass the skills and knowledge essential for mechanical engineering design. Those were knowledge of procedures, operational skills, social skills and cognitive skills.

Table 1. Engineering Design Competencies

No.	Type	Description	Engineering – All disciplines	
1	General knowledge	To understand a phenomenon, a situation, a problem, a process, etc.	Mathematics	Linear algebra, calculus, differential equation, probabilities, statistics, etc
			Basic sciences	Chemistry, Physics, Biology, earth Science, etc
			Engineering sciences	Mechanics, Materials, Thermodynamics, Heat Transfer, Mass Transfer, etc.
2	Specific knowledge in a professional environment	To know the technologies, the rules, the standards, the culture, etc.	Technologies, standards, regulations, safety, liability, intellectual property, ethic, role in the society	
3	Knowledge of procedures	To know the procedures, the methods, the processes, etc.	Product development process, engineering design process, engineering design tools (market research, functional analysis, QFD, design for cost and cost estimation, etc)	
4	Operational skills	To know how to use the procedures, the methods, the technologies, etc.	To have executed and practiced the design process	
5	Experiential skills	To know how to use tacit knowledge	Design by similarity, design by experience, etc.	
6	Social/Personal skills	To know how to listen, to cooperate, to work in team, etc.	Teamwork, communications, leadership, negotiation, professionalism	
		Initiative, thorough, curious, etc.	Initiative, thorough, curious, practical, humble, responsible, adaptable, confident, awareness, respectable, entrepreneurialism	
		To manage life (personal and professional), to feel (intuition, perception, etc.)	Self-awareness, managing emotions, motivating oneself, empathy and handling relationships	
7	Cognitive skills	To solve problem, to design, to manage a project, to take decisions, etc.	To know your limitations, to create, to look at the big picture, to manage project (including the system engineering perspective), to decide (decision-making), to learn how to learn, to manage information and knowledge, to define a problem, to define potential solutions, to learn from past experiences, to manage resources, to take and manage risk	

### 3. Model and Results of Internship in Local Industry

Model of industry internship in local industries was developed in two industries: UPT Logam in Yogyakarta and UD RekayasaWangdi in Sleman. Three groups of student internship took part in this model. They did this internship model for two months in these industries. Then in the next semester they took Final Project Course for one semester to continue working in the groups to manufacture what they had designed during the internship. In other this internship model is call an integrated internship model, where Final Project Course is initiated during the implementation of industry internship program.

The students implemented four-stage: (a) pre-placement, (b) initiation, (c) working, and (d) termination. They did pre-placement stage by identifying, investigating, interviewing and determining a local industry as an internship placement site with input from the potential internship supervisor and academic instructor. After a mutual decision is agreed upon, pre-placement activities include setting a work schedule, continuing contact with the future internship supervisor, rearranging personal schedules.

In the initiation stage, the students did orientation program for two weeks. They observed process of production and tried to find out the real problems in the industries under supervision. Then, during the working stage, the students worked in groups as regular workers to design and manufacture a machine. The students spent this stage for six weeks. In the termination stage, the students completed the tasks and wrote a report of the internship.

Products of the integrated internships model were three machines designed by the internship students. These machine were cutter machine, slondok molding machine and sifter machine.

#### 3. 1. Cutter Machine

The students who did the internship in UPT Logam Yogyakarta designed a cutter machine (Fig. 1). This machine is used in finishing process. Traditionally after the casting process, workers cut the pouring line of casting by using a handsaw. To cut one piece of part, it took for about 10 minutes and very exhausting. The machine is operated manually. In one minute, it can cut 12 pieces.

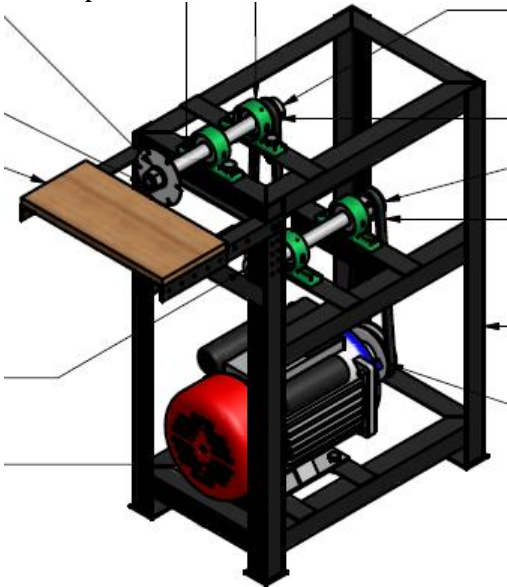


Figure 1. Cutter Machine

#### 3. 2. Slondok Moulding Machine

The students who did the internship in Bengkel Rekayasa Wangdi in Sleman designed a Slondok Molding Machine (Fig. 2). Slondok is a traditional food which is made of cassava as main raw material. Traditionally slondok is produced manually, as a result, the shape and dimension of slondok are not uniform. This traditional process is slow in production. It can only produce 3 kg for one day (8 hours) by one operator.

The molding machine is operated by using an electrical motor. The operator pours the raw material into the pouring hole. By using this machine, slondok can be produced in uniform shape and dimension. This machine can produce 40 kg for one day (8 hours) by one operator.

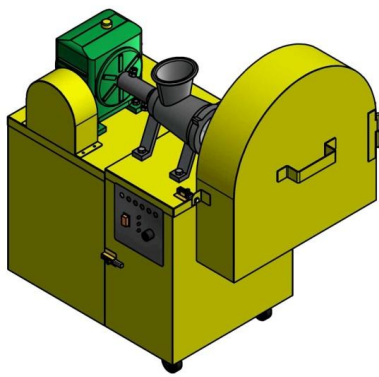


Figure 2.SlondokMolding Machine

### 3. 3. Sifter Machine

The second group of students who did the internship in UPT Logam Yogyakarta designed a sifter machine (Fig. 3). This machine is used to sort out aluminum waste. Traditionally after the casting process, workers sort out the aluminum waste manually. It takes time and is very boring. This manual process is also dangerous, because some chemical materials can harm the hands of workers.

The sifter machine is operated by using an electrical motor. The operator pours the waste material into the pouring case. Then a roll crushes the material into small pieces. Below the crusher, there is a sifter moving back and forward. By this way, sand can go through and is felt down, but the aluminum material remains. Because of the slope of the sifter, then the aluminum moves down and it is collected in a bucket.

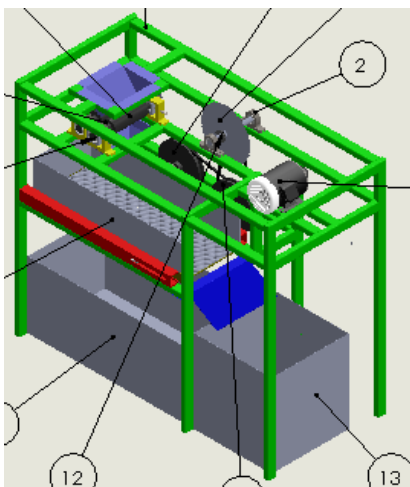


Figure 3.Sifter Machine

## 4. Measure of Design Competency

In this study the design competencies assessed were knowledge of procedures, operational skills, social skills and cognitive skills. Every internship student wrote a report about how he or she manufactured the parts of the machine. Therefore the reports were different between one student and others. To assess the knowledge of procedures, the examiner used the report.

To assess the operational and social skills, the examiner observed the students, when they were working in manufacturing the machines. This observation was intended to know how students chose and used the machines and tools, how they applied the procedures, the methods, and the technologies. This observation was also intended to assess every student's skills: to listen and speak to others individually, how to cooperate and to work in team.

The cognitive skills were measured by using oral examination. This examination was done by presentation of every student based on which parts of the machine they were responsible to manufacture. The students were asked about how they solved the problem, designed and managed a project, and how they took decisions.

The product performance test was done to assess the quality of the machine. Each group of the internship students presented their machine. Firstly, they explained how to operate the machine, how every part works and its utilities and specification. Then the machine was run to know how well the machine works.

## 5. Results

Students who take traditional internship programs are assessed by industry supervisors and by faculty supervisors. The results are combined to give final results. The faculty supervisor examines the internship students orally by examining the report written by the internship student. Mostly there is no direct communication between industry supervisor and faculty supervisor.

Results of the tests to students who took the integrated internship model showed that in all attributes of the competence

(knowledge of procedures, operational skills, social skills and cognitive skills of the students) were better than those of students taking conventional industry internship. Results from the product performance test showed that the machines produced by the students taking the program had worked well.

## **6. Conclusion**

Based on the results of this study, it can be concluded that four attributes of the design competencies could be assessed by using the integrated internship program. The students who took internship program in local industries were capable in designing machines. And all machines worked well. It showed that by doing internship program in local industries the students could increase their design competencies.

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